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Challenges for the Future of Agriculture and Forestry in North Carolina

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Report of the Committee on Agriculture and Forestry of the Governor's Task Force on Science and Technology

A Supplementary Report to:

New Challenges for a New Era
Progress Through Innovation, Education and Research

January, 1984

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Raleigh, North Carolina

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CHALLENGES FOR THE FUTURE OF AGRICULTURE AND FORESTRY IN NORTH CAROLINA

Report of the Committee on Agriculture and Forestry
of the Governor's Task Force on Science and Technology

A Supplementary Report to:

New Challenges for a New Era
Progress Through Innovation, Education and Research

January, 1984

Executive Summary

The economic prosperity and quality of life in North Carolina is determined in large part by investments in the technologies that make our agriculture and forestry enterprises both productive and efficient. To retain and enhance our place in the economic and social fabric of the United States, North Carolina must continue to support the scientific and educational enterprises from which tomorrow's technological advancements will come.

After nine months of study the Committee on Agriculture and Forestry recommends the following:

1) Increased state funding in eight priority areas of research and technology:

   a) biotechnology
   b) management of natural resources
   c) water use and conservation
   d) energy use and conservation
   e) comprehensive soil and crop management systems
   f) integrated reproductive management
   g) appropriate technology for small forest ownerships
   h) preservation and transport of food commodities after harvest

2) Removal of the following bureaucratic obstacles to research and technology transfer:

   a) Excessive centralization of control and standardization of procedures in construction of new facilities and requirements to rent research and office space.

   b) Excessively detailed levels of budgeting, and accompanying approval for fund-transfers.

   c) Loss of administrative flexibility in faculty and other appointments.

3) State and local initiatives to increase awareness of the importance of agriculture and forestry to the state's social and economic development.

Committee on Agriculture and Forestry
Governor's Task Force on Science and Technology

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PREFACE

This report was prepared by the Committee on Agriculture and Forestry of the Governor's Task Force on Science and Technology. The Committee is one of several that were formed to supplement the work of the Task Force. The Task Force consists of the 15 members of the North Carolina Board of Science and Technology, plus another 17 leading citizens from across the state, appointed by the Governor, to serve for a 15-month period ending in December, 1983. The goal of the Task Force was to evaluate the state's scientific and technological resources and recommend policies, procedures, organizational structures and financial requirements necessary to enable the people of North Carolina to realize additional economic and social benefits from the proper utilization of these resources. Copies of the final report of the Task Force, New Challenges for a New Era: Progress Through Innovation, Education and Research, can be obtained from the Office of the Governor, Raleigh. The report of the Committee on Agriculture and Forestry is intended to supplement the larger Task Force report.

In this report, emphasis is placed on investments in research and education required to ensure further improvements in the fields of agriculture and forestry. These fields are defined broadly to include related environmental, energy, agribusiness and other concerns. Even so, the coverage is limited. Marine life, urban-rural issues, mining, and other fields that comprise part of the interface between agriculture and forestry and the rest of society are omitted. All of the omitted fields are important; the Task Force simply had neither the time nor the resources to examine them properly. Subsequent reviews are needed to make up these deficiencies.

Many of the recommendations in this report are directed at the School of Agriculture and Life Sciences and the School of Forest Resources at North Carolina State University. To be sure, any successful strategy for strengthening agriculture and forestry research and development must be broad and comprehensive, involving many public and private institutions and organizations. The State Departments of Agriculture, Natural Resources and Community Development, and Labor each have a vital role in this process, as do N. C. A & T State University, UNC-Chapel Hill, UNC-Greensboro, and Duke University. Many of the significant R & D activities in agriculture and forestry in the state, however, are initiated at N. C. State. Thus, it is quite appropriate to fully utilize the resources at N. C. State to substantially upgrade agriculture and forestry R & D in North Carolina.

One omission of the current report stands out--the role of the small farmer. More specifically, the recommendations presuppose that the transformation of agriculture that has been taking place in the U.S. for several decades will likely continue. This transformation has resulted in a steady increase

in the size and an associated decrease in the number of commercial farms. Many farm families are either squeezed out of farming altogether, or forced to become small, low-income farmers or part time farmers.

Those farm families who, for whatever reason, do not keep pace with technological advance are somewhat comparable to the textile and other factory workers who are replaced by robots and various forms of sophisticated equipment. Technological innovation has negative as well as positive effects, and the costs of change are not necessarily assessed with justice and equity.

These costs emerge as unemployed or underemployed farmers, textile workers and others. As with the costs of environmental concerns, they often are not included in the determination of the production costs for either agricultural or industrial enterprise. We pass them on to society. They are identified by the economic term "externalities," and are considered to be costs that are external to the production unit. Nevertheless, they are costs to society; costs in terms of hardship, discouragement, and of lost purchasing power on the part of those who are not fully employed.

Another committee of the Task Force, the Committee on Science, Technology and Human Values, has devoted attention to the problem of unemployment, underemployment and other ramifications of technological innovation. The final report of the Task Force deals to some extent with these same issues, particularly in Volumes I and II. Additional attention will need to be given to these problems as we seek to enable all North Carolinians to benefit from effective use of scientific, engineering and technological resources.

Chapter One of this report sets forth a comprehensive strategy for pursuing innovative R & D in several components of the State's agriculture and forestry programs. Chapter Two discusses administrative obstacles to advanced research in all fields, not only agriculture and forestry. Chapter Three focuses on the need to develop locally-based awareness programs on the importance of agriculture and forestry to the state's economy. Each chapter contains a set of action recommendations, with associated budget requirements for each recommendation.

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CHALLENGES FOR THE FUTURE OF AGRICULTURE AND FORESTRY IN NORTH CAROLINA

Introduction

The economic prosperity and quality of life in North Carolina is determined in large part by investments in the technologies that make our agricultural and forestry enterprises both productive and efficient. Such investments pay handsome dividends to the people of our State through:

-satisfying jobs;
-wholesome food of high quality at modest prices;
-useful fibers for textile and paper products of many sorts;
-timber for homes and furniture;
-abundant wildlife;
-clean water; and
-a variety of recreational and aesthetic values.

These dividends are best provided through the effective and productive management of our farms and forests, our agribusiness and timber-products industries, and our parks and recreational facilities.

If North Carolina is to retain its strong and competitive place in the economic and social fabric of the United States and the world, the state must continue to support the scientific enterprises from which tomorrow's technological advances will come. Many of these advances will result from research in agriculture, forestry, and related renewable natural resources.

The major purpose of this report is to suggest the direction for these investments during the remaining years of this century. Recommendations will be of three major types:

1) priorities for investments in research in the sciences and technologies that undergird agriculture and forestry;
2) suggestions for removal of obstacles that presently impede the progress of scientific research in North Carolina;
3) priorities for improvement of scientific education and technology transfer from the research institutions of the state to those who can benefit from advances in knowledge of science and technology, and to the citizens of North Carolina.

In developing its recommendations for research the Committee on Agriculture and Forestry has benefited from a series of national studies of research priorities. We mention the following studies because of their substantial relevance to North Carolina:

a) Science for Agriculture -- Report of a Workshop on Critical Issues in American Agricultural Research -- Winrock International Conference Center, 1982.

b) Agricultural Research Service Program Plan -- USDA, Agricultural Research Service, Misc. Pub. No. 1429, 1983.

c) Criteria for Deciding about Forestry Research Programs -- U. S. Forest Service General Technical Report WO-29, 1981.

d) The Promise of Private Non-industrial Woodlands -- National Forest Products Association, 1981.

e) Our Natural Resources - Basic Research Needs in Forestry and Renewable Natural Resources -- National Task Force on Basic Research in Forestry, 1983.

f) Emerging Food Marketing Technologies: A Preliminary Analysis -- Office of Technology Assessment, U. S. Congress, 1978.

The Committee also benefited from two recent statereports on science and technology in North Carolina:

a) Agricultural and Forestry Research and Development in North Carolina -- Governor's Advisory Task Force on Small Woodlot Management, 1978.

b) Recommendations to Increase the Productivity of Small Woodlots in North Carolina-- Governor's Advisory Task Force on Small Woodlot Management, 1978.

Finally, the Committee sought the counsel of some of the most able faculty in the School of Agriculture and Life Sciences and the School of Forest Resources at North Carolina State University and North Carolina A&T State University, as well as key officials in the State Departments of Agriculture and Natural Resources and Community Development.

The Importance of Scientific and Technological Advances to Agriculture and Forestry

Agriculture and forestry provide products that are consumed by all members of society. Advances in science and technology have fostered major advances in food and fiber production, processing, and storage. These advances have released labor from agriculture to industry, and, as a result, individuals have been able to pursue other productive activities in society, further contributing to productivity increases in non-agricultural sectors of the economy.

At the same time, consumers have benefited dramatically from lower food costs. Currently American consumers spend a lower percentage of income on food than consumers in any other nation.

These distinct gains from technological advance have allowed the United States to become a major food exporting nation. North Carolina is the leading export state in the southeast. Agriculture is one of the few bright spots in the overall balance of trade picture today, still exporting at a rate greater than two to one over imports. One example of the country's strength is in the area of forest resources, where the southern United States is one of the world's largest sources of softwood fiber. Twenty-percent of the labor force in North Carolina is engaged in the growing and processing of timber products.

Yet, the rate of increase in productivity is slowing down in the agricultural sector. Renewed efforts must be made to ensure that our consumers at home and abroad continue to receive useful products at reasonable prices. Without these efforts, North Carolina may lose its strategic position as a major exporter of agricultural products. Without further technological advances, our competitive position will decline as other states and nations adopt new technologies.

Benefits to North Carolina from Scientific and Technological Developments in Agriculture and Forestry

From time to time every investment of public funds should be examined to ensure that it provides valuable benefits to society. One approach is to evaluate the economic returns that can be expected from the investment. Public expenditures for agricultural and forestry research have shown consistently high annual rates of return - typically about 50 percent per year.[1] Similarly high rates of return can be expected from future investments.

While most people accept the idea of federal government investment in research, some questions arise about state investments in basic research. Unlike private research and development, the results of public research frequently become part of the public domain. Questions about the distribution of benefits naturally occur. Are there benefits to North Carolina from investing in agricultural research when knowledge from discoveries is quickly disseminated to others? Can any state afford to finance such research, or should it depend on research

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[1]Evenson, Robert E., Paul E. Waggoner and Vernon W. Ruttan. "Economic Benefits from research: An Example from Agriculture." Science Washington:AAAS, Vol. 205 (Sept., 1979): 1103-1107.

done by the federal government or in other states? The answer hinges on the question of "spillovers" of research from one location to another. The research of Evenson and others [2,3] shows that maximum benefits do accrue to the state where the research originates.

It also appears that the more intense the agricultural industry is in the state, the greater the relative benefits from research expenditures. In 1976, for example, the estimated dollar return from each dollar of public investment in poultry research in North Carolina was $12.90[3] This relatively high rate of return was influenced by the concentration of the poultry industry in the state. This facilitated the capture of a large share of benefits in North Carolina.

In summary, the evidence shows a well documented and sustained history of large benefits from investments in science and technology relating to agriculture and forestry. High returns over such a long period of time lend support to the idea that agricultural and forestry research have been chronically underfunded. That is, if the investments were large enough, the rate of return would decrease as all of the frontiers of research were pushed back and the benefits become smaller and smaller over time.

The conclusion to be drawn from this analysis is that North Carolina would experience considerable gain from additional investments in science and technology research and development related to agriculture and forestry because the returns on such investment are high and much of the value could be captured in North Carolina. We also believe that important additional gains in productivity and quality of life can be achieved by improving communication and cooperation among various public, industrial, and private institutions and organizations within the state.

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[2]Peterson, Willis L. "A Note on the Social Returns to Private Research and Development." American Journal of Agricultural Economics 58 (1976): 324-26.

[3]Bredahl, Maury E. and Willis Peterson. "The Productivity and Allocation of Research: U. S. Agricultural Experiment Stations." American Journal of Agricultural Economics 58 (1976): 684-92.

CHAPTER ONE

Priorities for Investments in Science and Technology in Agriculture and Forestry

1. BIOTECHNOLOGY

Technical Needs. Biotechnology encompasses a wide range of powerful biological methods, including the recently acquired capabilities of manipulating and transferring genes and animal embryos, immobilizing enzymes, and culturing and propagating animal, plant, and microbial cells in vitro. Future advances in the application of biotechnology to agriculture and forestry are expected by many scientists to create a second Green Revolution. Applications include the development of disease-resistant plants, enhanced ability to fix nitrogen, and the ability to produce desirable chemicals and biological substances. One of the greatest opportunities for advantageous use of biotechnology is in the genetic improvement of forest trees. Selection and breeding of superior trees is a long-term process. Modern tissue culture and genetic engineering methods can greatly accelerate this process. For North Carolina to realize fully the potential benefits of biotechnology, much stronger support is needed for programs in research and education, industrial liaison and business development, and promising new scientific ideas. The North Carolina Biotechnology Center was established in 1981 to foster strong research and education programs in this field.

Research and education programs in North Carolina should have the following characteristics:

(i) Focus on scientific problems that are of importance to the advance of biotechnology,of interest to industry, and relevant to the needs of North Carolina.

(ii) Complement and strengthen existing research and teaching programs.

(iii) Encourage collaboration in research and teaching among scientists and engineers from several disciplines in universities, and also between scientists from universities and scientists from industry.

(iv) Support equipment and facilities that can be shared by several scientists and universities.

(v) Support training of high quality students.

(vi) Enlist financial support from industry, foundations and the federal government, in addition to state support.

State support for such programs should be provided directly to the universities and through the Biotechnology Center. The funds provided to the universities for research on applications

of biotechnology to agriculture and forestry should be concentrated in those institutions with the greatest competence in biotechnology related to agriculture and forestry. The funds provided to the Biotechnology Center should be used to encourage new initiatives in all fields, including agriculture, and to enhance cooperation among universities and between universities and industry.

Industrial liaison and business development efforts should focus on two objectives: recruiting new industry to the state and nurturing the development of new and existing businesses within the state. The programs will require cooperation among the Biotechnology Center, colleges and universities, the Commerce Department, the N. C. Technological Development Authority, local chambers of commerce, and others concerned with economic development.

The Center and the Commerce Department have cooperated in preparing an industrial recruitment brochure, "Biotechnology in North Carolina." The two groups must now work together in recruiting biotechnology industry to North Carolina. One example of the benefits that can accrue from these efforts is the recently-announced decision by CIBA-Geigy to locate a new unit in agricultural biotechnology in North Carolina.

In nurturing the development of new and existing businesses within the state, the Biotechnology Center should help create networks of and stimulate interactions among scientists, entrepreneurs, and sources of financial, management, and technical assistance. The Center should develop a resource base of all such persons and groups interested in biotechnology. Also, it should assist groups which are conducting conferences and pursuing other approaches for encouraging new business development in North Carolina.

Promising new initiatives must be encouraged. It is critical that scientists and engineers have the opportunity to pursue untried ideas that hold promise for scientific advance, technological development, and effective education. If the results of these early research and training programs show promise, it is anticipated that additional resources to carry the work further will be obtained from other public and private sources. In the research area, emphasis should be on young investigators in universities and persons starting or expanding small businesses.

Institutional Arrangements. Several universities in North Carolina are initiating expanded programs in biotechnology. The Biotechnology Center is increasing its capabilities to foster multi-disciplinary and multi-institutional research and education programs and to foster university-industry cooperation. The Commerce Department is placing emphasis on recruiting biotechnology industries. The pieces are in place. Greater effort is still needed, however, in devising the means for the individual units to work together more productively. It is in

these collaborative efforts that North Carolina has a competitive advantage, and the state needs to use this advantage more effectively. Strengthening the overall biotechnology program will benefit the State in a variety of ways, including the enhancement of North Carolina's agriculture and forestry enterprises. Therefore, the committee endorses a strong commitment to expanding research and development in biotechnology across all fields. The budget requirements reflect such commitment.

Budget Requirements.

	FY 1985	FY 1986	FY 1987
A. Research and Education	$4.3 million	$8.2 million	$8.2 million
B. Industrial Liaison and Business Development	0.1 million	0.2 million	0.2 million
C. Promising New Initiatives	0.5 million	1.5 million	1.5 million
D. Communications	0.1 million	0.1 million	0.2 million
TOTAL	$5.0 million	$10.0 million	$10.0 million

2. MANAGEMENT OF NATURAL RESOURCES

Technical Needs. Many of the critical natural resource issues facing North Carolina today are extraordinarily complicated. Examples include:

- surface water quality in the major river basin systems of the state;
- changes in water tables and ground water quality associated with phosphorus mining, peat mining, and waste-disposal operations;
- interbasin transfers of water, including use of the Roanoke River system to satisfy water demands in Tidewater Virginia;
- acid deposition and other changes in the air quality and chemical climate of the state;
- wilderness management policies in western North Carolina;
- changes in patterns of tourism in eastern and western North Carolina;
- continuing development of the Outer Banks and the issue of a permanent inlet through the banks;
- use of fossil peat and buried wood resources in coastal areas;

- influence of land-use patterns, climate change, and urban-industrial development on fishery resources;

- needs for marine climate and weather advisory services;

- impact of forest management and agricultural practices on wildlife habitat and quality.

- lack of management of private, non-industrially owned forest lands.

All of above issues, and many others, involve multiple state, federal, and local government agencies. Several matters affect the state's response to these issues: conflicts over public and private benefits and costs; the need for multiple disciplinary competencies; resolution of jurisdictional conflicts; needs for public education; and development of community, county, regional and state leadership. A common commitment is needed by state agency, university, industry, and political leaders to:

- seek out areas of coordination and cooperation,

- establish systems of mutual trust and confidence, and

- help in the discovery of useful knowledge and the formulation and evaluation of alternative plans for management of natural resources.

The School of Forest Resources, the Department of Marine, Earth, and Atmospheric Sciences, and the Center for Environmental Studies at North Carolina State University as well as the Water Resources Research Institute and the Sea Grant programs of the state all have substantial capacity to contribute to the resolution of the issues and the achievement of the common commitments listed above. But each of these organizations face such critical shortages of space in their present facilities at North Carolina State University that their capacity to meet the technical needs listed above are seriously limited.

Institutional Arrangements. The Committee on Agriculture and Forestry endorses the concept that a Natural Resources Research Center be established at North Carolina State University. The major purpose of this Center should be to provide technical-scientific services to public and private natural resource organizations (e.g., federal, state, county, and local governments, as well as industry). Preference should be given to North Carolina governmental bodies and agencies. The Center should facilitate organization, planning, and funding of interdisciplinary research and assessment projects. It should encourage development of new and innovative approaches to solving natural resource problems and should facilitate communication among government, academic, and private-sector interests.

The Center should provide a service on natural resource management, through research and analysis, to the legislature, state agencies, local government, and private industry.

Usually, requests for advisory service or research should be initiated by the organization seeking the information. From time to time, however, suggestions about information needs could flow from university personnel to leaders in relevant agencies or organizations.

The costs of obtaining the information or research results that are needed generally should be born by the organization seeking the information. Some university funds to sustain Center personnel also would be desirable. In addition, grants and contracts should be obtained from federal and other agencies interested in natural resources.

Faculty members whose expertise is needed to fulfill a given need for information will be drawn from the various schools and departments. The following units at North Carolina State University are suggested as having strong expertise in the areas in which the Center should be involved:

- School of Forest Resources, Departments of Forestry, Recreation Resources Administration, Wood and Paper Science, and Forest Resources Extension.

- School of Physical and Mathematical Sciences, Department of Marine, Earth, and Atmospheric Sciences.

- Water Resources Research Institute

- The Sea Grant Program

- The NCSU Center for Environmental Studies

Affiliated units would include various departments within the School of Agriculture and Life Sciences and the School of Engineering.

Linkages with other universities should also be established and, as the program develops, particular scientists and other institutions should be involved in the advisory and research services of the Center.

Facilities planning funds for the Natural Resources Research Center were provided during the 1983 Legislative Session.

Budget Requirements.

	FY 1985	FY 1986
Construction of a Natural Resources Research Center	$7,500,000	$7,500,000

3. WATER USE AND CONSERVATION

Technical Needs. Water-resource management and conservation represent some of the greatest opportunities and challenges for agriculture and forestry in North Carolina for both the short and long term. Forest and agricultural lands serve as the prime receivers of precipitation and thus have a major role in the use, conservation, and quality of our water resources. Water is a major output from forest management, and a major input into agriculture. Proper water management represents a major opportunity for increasing yields of many crops.

Agriculture is by far the largest consumer of water in North Carolina. Drought conditions during the past several years and the expanding demands for water in North Carolina underscore the key role that water quantity and quality have on our future productivity and quality of life.

In the area of water use and conservation, many important problems exist in North Carolina. These include:

-finding more efficient ways to use surface and ground water in agriculture and forestry. This includes improving irrigation efficiency, reducing water use, identifying physiological mechanisms for stress tolerance in plants, and developing stress-resistant varieties.

-determining the effects of various farm and forest practices and acid rain on water quality in receiving streams and estuaries. The use of forested areas in the lower Coastal Plain for receipt of agricultural drainage needs particular study. This research is of special importance for the further development of North Carolina's commercial and sport fishery resources.

-investigating the supply and chemical quality of ground water in North Carolina and finding ways to conserve and protect it.

-evaluating legal and economic alternatives for allocation of water among agricultural users and between agricultural uses and other sectors, particularly in areas where irrigation may result in water-use conflicts.

-developing improved ways to recycle water in food and fiber processing and production of pulp and paper products in order to reduce total water usage, minimize pollution of surface waters, and maximize recovery of chemical and usable byproducts.

Institutional Arrangements. The technical needs listed above should be met by three general methods outlined below:

1) Adding to the support base of the University of North Carolina Water Resources Research Institute (WRRI) and thus increasing its capacity to encourage water-related research in many of the colleges and universities of the state.

WRRI has a long-standing record of filling gaps in existing knowledge of water use and conservation in North Carolina. Initiatives based on WRRI grants frequently have stimulated the various colleges and universities of the state to develop stable programs of research in one or another facet of water resource management. Research on ground-water will be a major emphasis of WRRI in the years ahead. The institute is also considering the establishment of a visiting scientist program in addition to its traditional grants programs. The Committee on Agriculture and Forestry endorses both of these plans for the future and recommends additional funding as shown below under Budget Requirements.

2) Strengthening the research and extension programs in agricultural and forestry hydrology at North Carolina State University.

Additional faculty and graduate student positions and increased coordination of water-related research and extension functions are needed within the North Carolina Agricultural Research and Extension Services. Additional research and extension positions should be considered in the Departments of Biological and Agricultural Engineering, Soil Science, Forestry, and other selected crop and life science departments. The objective should be to focus research and advisory services on water movement at both the macro and micro scales - from whole river basins and watershed areas to individual fields.

Coordinated leadership for water resources research and extension activities should be provided identifying persons within the North Carolina Agricultural Research and Extension Services. These individuals should have the responsibility and time to develop appropriate new initiatives in research and extension, as well as to provide coordination and direction to ongoing programs concerned with water resource management. The objective of this coordination should be to ensure a maximum gain in understanding of water-related phenomena and in assistance in the development of new technologies for water conservation and use in the state.

3) Improving communication and cooperation among the various water-resource agencies and institutions throughout the state.

As in so many other aspects of natural resource management, responsibility for water resource management in North Carolina is divided and therefore fragmented among various overlapping state, federal, county, municipal, regional, university, industrial, and public-interest organizations. Greater coordination among these

overlapping and often conflicting interests should be achieved by establishing a Governor's Interagency Advisory Committee on Water Management, with representatives from each of the major public and private research and advisory service organizations relating to water use and conservation.

Budget Requirements.

	FY 1985	FY 1986	FY 1987
A. Strengthening WRRI	$200,000	$300,000	$300,000
B. Strengthening water-related research and extension at NCSU	$250,000	$300,000	$300,000
C. Improving Coordination among water-resource organizations	$ 20,000	$ 20,000	$ 20,000
TOTAL	$470,000	$620,000	$620,000

4. ENERGY USE AND CONSERVATION

Technical Needs. North Carolina has no significant domestic sources of fossil fuels. Thus, the state maintains a huge ($5,000,000,000 per year) balance-of-payments deficit with other states for coal, gas, and petroleum sources of energy. In recent years, households using wood as primary source of heat have increased from 5 to 16 percent. Industrial users of wood for energy have increased by about 10 percent in the same period. In the long run as much as 10 percent of our total in-state energy requirements could be met on a sustained basis by use of wood and other biomass for energy. This would mean that North Carolina could retain within its borders $500,000,000 that are now exported to other states to meet our energy requirements. It would also mean that large areas of unproductive and low quality forest which now literally stand in the way of more efficient management could be replaced with more productive, economically valuable, and attractive forest stands. An accelerated program of advisory services to industrial, commercial, institutional and residential users of energy should be considered and coupled with increased advice to forest owners and wood-processing industries about producing wood for energy.

Since North Carolina's agriculture is almost totally dependent upon imported petroleum-based fuels, increased research and extension activities are needed to reduce energy use and costs by substitution of alternate fuels and by conservation methods. It must be remembered, however, that agriculture is using only a small portion of total energy consumed by society. Thus, improvements in agricultural energy use will not have major impacts on total energy consumption.

Opportunities to reduce energy use appear promising in all areas of agriculture and forestry, including production, processing, marketing, transport and consumption. The major area

for savings, however, is in crop drying. An overall reduction in energy use of 10 percent in these areas would provide energy savings in North Carolina estimated at $280 million per year. Continued emphasis should be placed on research and development of energy-saving technology for agriculture and forestry, using combinations of conservation, solar energy and alternative fuels. These new technologies need to be extended to potential users as quickly as possible through aggressive educational programs.

Much woody biomass and certain crop residues could be used for direct combustion, gasification, or conversion into alcohol or other chemicals. In the near-term, increased applied research and demonstration programs are required on the direct combustion of biomass. Over the long-term, increased investments in basic biological and chemical research are required to improve the efficacy of the conversion of biomass into alcohol and other chemicals. Applications of biotechnology will be important in improving the conversion processes.

Institutional Arrangements. The Wood Energy Coordinating Group, which includes the Departments of Commerce and Natural Resources and Community Development and the universities, needs to be strengthened.

The Energy Policy Council needs to be strengthened and provided with strong technical staff support to serve as the state government unit that maintains an overview of energy supply and utilization issues and of the needs for research and demonstration projects. This unit must include participation by the state Departments of NRCD, Agriculture, and Commerce, the universities, and industry. The Council should work closely with the Board of Science and Technology in developing R&D programs and with the Biotechnology Center in developing biomass conversion projects.

Additional investments of $1.5 million per year over five years are required to initiate the near-term and long-term demonstration and R&D programs mentioned above. The largest return on these investments and the biggest potential breakthroughs will come from improvements in the conversion of biomass to fuels. Therefore, a substantial portion of these funds should be allocated to long-term, basic science projects on biomass conversion.

Budget Requirements

		FY 1985	FY 1986	FY 1987
A.	Research and Development Projects	$ 500,000	$ 500,000	$ 500,000
B.	Demonstration Projects	1,000,000	1,000,000	1,000,000
	Total	$1,500,000	$1,500,000	$1,000,000

5. COMPREHENSIVE SOIL AND CROP MANAGEMENT SYSTEMS

Technical Needs. The complexity of crop production continues to increase with improved technology, the need for better soil and water management, and changing market conditions. Traditional systems of single-crop management may not work well in the future. New management strategies are needed to capitalize on the resources available for maximum return while conserving and protecting our natural resources.

To meet grower needs, research is needed on production systems that consider the entire farm, groups of farms, or in some cases, all the farm and forest land in an entire watershed. Soil and water management, crop selection, and pest management are the backbone of the system. Also included will be double-cropping, crop rotation, various tillage practices, and both marketing methods and components of demand for various food and fiber commodities. Because of the diversity of crop species, soils, and climate in North Carolina, a series of systems will need to be evaluated throughout the state. To develop the required information, interdisciplinary research teams will need to identify yield-limiting components for major production systems, develop component models, evaluate models, and develop farm-level management systems that utilize models in the decision making process. The ideal system will allow the farmer to maximize return on his investment, enhance farm income, improve the quantity and quality of food available to the consumer, conserve soil and water resources, and meet changing marketing and demand conditions.

Institutional Arrangements. A ten-year program of research on Comprehensive Soil and Crop Management should be initiated. A core unit should be established with sufficient support to faculty in other departments to enhance their capacity to function as a team.

Budget Requirements.

	FY 1985	FY 1986	FY 1987
Comprehensive Crop Management Research	$500,000	$500,000	$500,000

6. INTEGRATED REPRODUCTIVE MANAGEMENT

Technical Needs. A major obstacle to more efficient production of food and fiber from livestock and poultry is the reproductive rate of the breeding herd or flock. Efficient production of meat, milk and eggs depends on efficient reproduction because overhead costs per unit depend on the rate of output from breeding herds and flocks. If the reproductive rate is low, overhead costs are spread over too few units of the end product. Thus, by increasing reproductive rate, overhead costs per unit of product are reduced.

Integrated Reproductive Management (IRM) is aimed at increasing reproductive performance in livestock and poultry through identifying the limitations on reproduction and by developing and applying technology that overcomes these limitations. To this end, IRM will coordinate the efforts of research, teaching, extension, federal and state agencies, and industry toward a common goal -- improving reproductive performance in livestock and poultry. This multi-disciplinary and multi-agency approach should lead to an increase in efficiency of production through increasing reproductive rates of herds and flocks.

Institutional Arrangements. A ten-year program of research and extension on Integrated Reproductive Management (IRM) should be initiated in the Departments of Animal Science, Poultry Science, and Food Animal and Equine Medicine at N. C. State University. Since the IRM program would be conducted mainly in commercial livestock herds and poultry flocks, five field technicians are needed to initiate the program with leadership provided by Research-Extension faculty in the above three Departments.

Budget Requirements.

	FY 1985	FY 1986	FY 1987
Integrated Reproductive Management Program	$500,000	$500,000	$500,00

7. APPROPRIATE TECHNOLOGY FOR SMALL FOREST OWNERSHIPS

Technical Needs. Two-thirds of North Carolina's total land area is in forest. Sixty-nine percent of this huge land area is in tracts of 20 to 500 acres owned by 250,000 families. Every one of these owners has his or her own goals for management of this land for timber, wildlife, recreation, water, and aesthetic or other values. Appropriate technology with which to meet some mix of these goals is available but for some it is not adequate to achieve anywhere near the full productive potential of the land. Technical assistance and education of small woodlot owners are provided by five principal groups: university extension specialists, county extension agents, Division of Forest Resources service foresters and forest rangers, industrial land-owner assistance foresters, and private forestry consultants. All five groups need to be strengthened both in terms of available manpower and in terms of knowledge and breadth of experience with alternative management systems for various types of forest lands and owner management goals.

Institutional Arrangements. The technical needs of small forest owners should be met by strengthening the Small Woodlot Research and Development Program in the Department of Forestry, the Extension Woodlot Management Program in the North Carolina Agriculture Extension Service, and the N. C. Division of Forest Resources' Forest Landowners Assistance Program.

The expanded effort in the Small Woodlot Research and Development Program should include specialized studies of market development, growth and yield on small forest tracts, timber stand improvement methods, forest productivity maps and indices for various regions of the state, forest wildlife and recreational uses of small woodlots, and silviculture of managed natural stands. These new research efforts will require an intensive effort for a period of 5 years, followed in several cases by observations of experiments and demonstrations over the life of the forest stands.

Additional area forestry extension agents, service foresters and forest rangers should be appointed in parts of the State which have greatest potential for increased forest management. Agents should develop broad educational programs, including use of mass media, support of landowner associations, tours and demonstrations, effective youth programs, and workshops for various target audiences. The employment of additional area agents should allow existing specialists to prepare additional resource materials for county use and give them the time to develop innovative techniques to reach various segments of the forestry audience. Funding for forest rangers and additional foresters will increase the Division of Forest Resources' ability to provide on-the-ground technical assistance to more woodland owners.

Budget Requirements.

	FY 1985	FY 1986	FY 1987
Additional support for the Small Woodlot R&D Program	$350,000	$350,000	$350,000
Additional support for the Small Woodlot Extension Program	$180,000	$190,000	$200,000
Forest Rangers and Service Foresters	$130,000	$130,000	$130,000
TOTAL	$660,000	$670,000	$680,000

8. PRESERVATION, PROCESSING, TRANSPORT, AND DISTRIBUTION OF FOOD CROPS AFTER HARVEST

Technical Needs. In recent years, major needs for improvement of food-processing systems have emerged in North Carolina. These needs result in part from increasing energy and transportation costs, demand for better methods of waste water management, the desire of food processors to develop uses for underutilized food resources, growing demand of consumers for improvement of the nutritive quality of food products, improved food safety, and the avoidance of chemical preservatives. These demands and consumer preferences can be met in part by application of new technologies, including new fermentation methods, pasteurization techniques, immobilized enzyme technology, computer process con-

trols, innovative methods for altering the texture and flavor of food products, and greater communication and other interactions with state, federal, and industrial regulatory authorities.

Institutional Arrangements. A long-term cooperative program of research and technology transfer should be initiated in appropriate departments at North Carolina State University, North Carolina A & T State University and in the North Carolina Department of Agriculture.

		FY 1985	FY 1986	FY 1987
A.	New and improved microbial processes	$ 50,000	$ 50,000	$ 70,000
B.	Energy conservation and waste-water management in food processing	$100,000	$110,000	$120,000
C.	Increased use of underutilized food resources	$120,000	$120,000	$130,000
D.	Maintain and increase food safety and nutritive quality	$120,000	$120,000	$140,000
	TOTAL	$390,000	$400,000	$460,000

CHAPTER TWO

OBSTACLES TO RESEARCH AT NORTH CAROLINA'S UNIVERSITIES

Basic and useful research in agriculture, forestry, engineering and other fields of science and technology have added greatly to the economic prosperity and the quality of life in North Carolina, the southern region, the United States, and around the world. The state's universities have the quality faculty and graduate student body, much of the needed financial resources, the administrative support, the record of previous achievement, and the present momentum needed to maintain and enhance research quality and output as the state confronts new economic and social challenges.

Three points of special concern are highlighted:

A) As has been cited in numerous reports, many universities in the United States are suffering from a decline in the physical plant (space & facilities) aspects of their research endeavors - particularly in comparison to other countries that are competitive in science and technology. The lack of appropriate research facilities and the shortage of contemporary scientific equipment is a major hindrance to optimizing research productivity and also hinders new initiatives in promising fields.

B) Particularly in recent years the growth of management constraints, both at the federal and the state level, have increasingly burdened the research community--consuming ever increasing amounts of time and energy of research personnel and thus reducing their research output efficiency.

Creative research and scholarship are among the most demanding of intellectual pursuits. But much of the creativity necessary for research success is now invested in learning how to live with or circumvent one or another procedural or policy constraint. Good research administration has been defined as a "removal of obstacles to research."

The principal concern here is the need to increase, rather than reduce, the flexibility and adaptability of the research community of the universities.

C) Concern on the part of the state legislature and other responsible administrative agencies of state government with maintaining close accountability and monitoring of funds has resulted in overly centralized management and decision-making. This further aggravates and accents problems at the research level.

Some specific examples of the above categories of hindrances are offered, together with recommendations to improve the environment for research productivity.

Category A - Space, facilities and equipment

Particularly in the fields of agriculture and forestry the lack of adequate and appropriate research space and equipment is an increasingly urgent problem. More than any other segment of the university these units have been forced to rent off campus buildings and construct off campus modular low cost structures (other than for the designated regional field stations) in order to carry on their research activities. This situation builds continuing inefficiencies into the system as well as added costs of operation over the long term. Research space is now "supersaturated", and the difficulties of launching new initiatives such as expansion of biotechnology or remote sensing are formidable.

Additionally, under the current procedures to obtain approval for the construction or rental of research and other structures, long-term d elays resulting from the need for state level approval are the norm situation whether or not state appropriations are involved.

Recommendation. It is recommended that more responsibility for self management of buildings and rental of structures be delegated to the research universities by substantially raising the limits for construction bids and rentals which could be authorized by the respective chancellors without the need for approvals and processing by the state.

Category B - Need for Flexibility of Budget Management at Research Operational Level

i) Excessively Detailed Levels of Budgeting

The State of North Carolina has revised its system of budgeting from a general category object level, i.e. Supplies-2000, Current Services-3000, and Capital Outlay Equipment-5000, to a detailed object level, i.e. Educational Supplies-2300, Repair Supplies-2400, Office Supplies-2600; Travel-3100, Communication-3200, Printing and Binding-3400; Office Equipment-5100, EDP Equipment-5200, and Educational Equipment-5300. These more detailed budget codes lead to inflexibility. Administrators may expend funds for purposes that are not as critical to their program as other areas simply because the funds will be lost unless they are expended. It is virtually impossible in a research program to be as precise in predicting the areas in which funds will be needed, as may be the case in more service oriented programs. At present, preparation of the change budget requests is as much as 2.5 years prior to the time the budget is authorized for expenditure. For these reasons, there is need for more flexibility in the matter of budgeting funds for research

programs.

The change to the detailed object level has also increased substantially the number of transfer requests. Administrators now have to formally request shifts in budget structure among detailed objects within general object categories. Under the previous arrangements this was not necessary.

Recommendation. We recommend that budgets be allocated to the universities in three separate categories: salary, capital improvements, and operations (everything other than salary and capital improvements), rather than the individual object line item system now used. Such a system would allow more flexibility at the implementation level and substantially reduce unnecessary paper work and time now required to make budget transfers between object lines. At the same time it is believed that monitoring and accountability of expenditures could also be undertaken more efficiently.

ii) Time and effort for reporting to U. S. Government Agencies

University researchers receiving federal funds are required (under the terms of OMB Circular A 21) to report expenditures of total working time by category to a designated federal agency even though the federal fund support might at times be minimal. The continuing burden of paperwork and some mistrust which this creates is an example of non-productive use of potentially creative time.

Recommendation. Although this is a problem generated at the federal level, it is recommended that the state pursue the matter with a view to either reducing or negating the reporting requirement.

Category C - Need for More Management Delegation to Research Universities

i) Prompt acquisition of supplies and equipment

One of the significant disadvantages of the current system of purchasing is that state level approvals must be obtained for certain categories of supplies and equipment and certain levels of expenditure (even though the budget is approved and funding available) and also bidding must be conducted through state channels.

This system mitigates strongly against prompt and efficient acquisition of supplies and equipment, not only because of delays but also the additional paperwork involved.

Recommendation. We recommend increased delegation of purchasing procedures to the research universities to reduce state approval and state-managed bid procedures.

ii) Personnel Appointments.

A continuing problem is that of direct state level involvement and approvals of SPA appointments and classifications which create problems in obtaining and keeping adequately qualified personnel to support research operations. This area was described by one school dean as the most frustrating area that he had to deal with in his career at one research university in North Carolina.

Recommendation. It is recommended that more autonomy in personnel matters be provided to the research universities.

Although the above samples are by no means an exhaustive list of the organizational hindrances to carrying on research, they are situations which can be improved and still provide a necessary level of monitoring and accountability of public expenditures by the state.

The intent in this chapter is not to target blame for problems at any particular institution, agency, or individual. Rather, efforts should be initiated as soon as possible to develop alternative systems of management which allow greater flexibility without sacrificing fiscal control and integrity.

CHAPTER THREE

Increasing Public Awareness of the Importance of Agriculture and Forestry in North Carolina

Specific local education and awareness programs highlighting the importance of agricultural and forestry technology are important to the future of these industries and the people who are employed in production, processing and marketing of agriculture and forestry products. Local initiatives would provide a focus for interaction among the business and industry infrastructure, agricultural agencies, the general public and local leadership.

The goals of a comprehensive education/awareness program would include:

a. Bring to the attention of the key local leadership the influence of agriculture and forestry programs in the life of the community and the individuals living therein;

b. Develop an awareness among all citizens of the importance of technological innovation to the agriculture and forestry industries and the importance of critical policy decisions to their future;

c. Increase the awareness among all citizens of the need for greater investments in technological innovation and application to these industries;

d. Among students, focus on the potential of rewarding and productive careers in science and technology as a support system for agriculture and forestry.

A comprehensive program for community education and awareness of importance to agriculture and forestry should be formulated by individuals from within local communities across North Carolina. Local planning teams consisting of representatives from business, agriculture, forestry, government, elementary and secondary schools, colleges and universities, and civic organizations should be organized to coordinate the efforts. The teams would adopt goals similar to those above and conduct during the year a series of programs calling for both adult and youth involvement. The program elements need further research and development, but could consist of new or ongoing activities such as:

a. The Johnston County Public School and Extension Service model for scientific exploration and understanding of agriculture and forestry by young people;

b. Policy or issue forums for adults patterned after the successful regional forums of the Task Force on Science and Technology;

c. Local activities such as "farm city weeks," fairs and displays and promotion of the importance of science and technology to the industries in the local area;

d. Involvement by local media in all of the activities.

The success of these activities at the local level would be enhanced if the program had a name or theme attached and if there existed state funding to provide material, equipment and leadership to assist in program initiation. State funding would constitute "seed" money to be used as a match for additional local funding.

Such programs should be initiated in at least six pilot counties with wide geographic distribution as early as feasible. The primary criterion in selecting a county for participation should be that county's demonstrated enthusiasm for the projects.

Reports or documents should be prepared that detail the model programs available and relate the successes and concerns of the six pilot efforts. Another publication identifying critical policy issues developed from the forums would provide a valuable resource to key decision makers. These reports would provide support mechanisms for additional county and/or community involvement.

In addition to these locally-based awareness programs, a more formal effort should be devised to increase the exchange of technical and managerial information related to agriculture and forestry issues among business, government and education officials at the state and local level.

The Agriculture Extension Service, or a comparable agency, should establish regional Task Forces consisting of representatives from agriculture industry, universities, small business, state and local government, and others to encourage an exchange of information on agriculture and forestry issues. Specifically, these local Task Forces might:

a. Implement formal exchange programs whereby university scientists might work in large or small farm businesses for a defined period in order to provide specialized expertise;

b. Create a formal technical assistance program which enables individuals from large and/or small farm businesses to obtain hands-on experiences in university or industrial labs with the latest technological

advances and learn about their application to agriculture and forestry production;

c. Encourage an ongoing dialogue among farm businessmen, agriculture researchers, government officials and others on the issue of preserving the state's natural resources and ensuring environmental health and aesthetic beauty.

In addition to the establishment of new awareness programs for the general public, the State Department of Public Instruction should encourage the introduction of agriculture and forestry sciences into course curricula for grades K-12. Many students, even those with a strong science background, currently receive little exposure to agriculture and forestry during their course of study.

Finally, the Committee supports the efforts of the Legislative Study Commission created in 1983 to examine alternatives for increasing public awareness of the importance of agriculture, forestry and seafood in North Carolina, and recommends that additional funds in the amount of $40,000 be appropriated to the Commission.

Budget Requirements

	FY 1985	FY 1986	FY 1987
A. Local Awareness Programs (6 @ $5,000)	$ 30,000	$ 30,000	$ 30,000
B. Additional Support for the Legislative Study Commission	$ 40,000	-	-
Total	$ 70,000	$ 30,000	$ 30,000

The local technical/information exchange programs should be supported with existing funds and with private monies.